TECHNICAL MEMORANDUM

River Mile 10.9 Removal Action –

High Sub-grade Cap Design

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Summary

This technical memorandum presents a revised cap cross-section design for RM 10.9 near shore areas where high sub-grade prevents excavating 2 feet of sediment prior to placing the cap.

As required by the approved Final Design Pursuant to the RM 10.9 Removal Action Waterfront Permit Equivalent issued by NJDEP, the top of cap elevation must be no higher than the original sediment surface elevation. In the vast majority of the RM 10.9 sediment excavation, the top of cap will be less than the original sediment surface because the 2 feet of excavated sediment is greater than the 22-inch-thick cap design thickness. The 22-inch-thick cap cross-section design consists of an average of 10 inches of active layer material, geotextile, 12 inches of Type A (D_{50} = 4.5 inches) armor stone, and a thin sand layer just covering the top of the armor stone. However, in some near shore, areas, high sub-grade (i.e., very hard-packed material comprising weathered stone, clay and cobble) has prevented and will prevent excavation of 2 feet of sediment. As a result, the cap design requires modification to reduce its thickness in those areas.

A revised cap design was developed for placement in high sub-grade areas where at least 1.75 feet of sediment cannot be excavated prior to placing the cap. It is assumed for purposes of this design that residual contaminated sediment would remain on top of the high sub-grade as mechanical dredging cannot fully remove all sediment on top of this hard material. The revised cap would be placed to isolate this residual contaminated sediment. The revised cap design (see Figure 1) consists of 6 inches of active material (i.e., the same AquaGate and sand mixture as the standard RM 10.9 cap design), geotextile, 6 inches of Type B (D_{50} = 2 inches) armor stone, and a thin layer of sand just covering the top of the armor stone. Based on results from the CapSim analysis, the revised cap cross-section is expected to be protective for those conditions in near shore areas (i.e., water depths less than 3-feet-deep) with a high sub-grade.

Armor Layer Design for Near Shore Areas

As noted in section 7.2.3.1 of the Final Design, an armor layer with a minimum thickness of 4.5 inches using Type B armor stone (D_{50} = 2 inches) is protective in the near shore areas (i.e., less than 3 feet of water depth). Therefore, where high sub-grade prevents placing a cap with the standard RM 10.9 12-inch-thick Type A armor stone layer, an armor layer utilizing Type B armor stone may be substituted. The average Type B armor stone layer thickness should be 6 inches with a minimum of 4.5 inches.

Active Layer Design for High Sub-Grade Areas

The active layer of the standard RM 10.9 cap design was also evaluated to determine if a thinner layer could be used that would be protective for the high sub-grade areas. The high sub-grade will reduce the groundwater seepage through the cap. Groundwater seepage through the cap as measured by Darcy Velocity greatly impacts the active layer's design thickness. If all other factors are the same, less groundwater seepage through the cap (i.e., lower Darcy Velocity) requires less active layer thickness to achieve the same level of protectiveness (i.e., same time to breakthrough). The small amount of sediment remaining above the high sub-grade would also tend to reduce the active layer thickness, although this factor was not specifically evaluated.

The CapSim model was utilized to perform a sensitivity analysis of the impact of reduced groundwater seepage on the active layer design. The sensitivity analysis was based on the following:

- Chemical evaluated: PCB 52 (mobile PCB congener as was used in cap design)
- Pore water concentration: 13.85 µg/L (site-wide average total PCB concentration as was used in cap design)
- Breakthrough Criterion: 6.4 x 10-5 µg/L (NJ Surface Water Quality Standard [NJSWQS] for Total PCBs as was used in cap design)
- Sensitivity Analysis Variables
  - Darcy Velocity
    - 307 cm/yr (site-wide average as was used in cap design)
    - 154 cm/yr (50% of average Darcy Velocity)
    - 77 cm/yr (25% of average Darcy Velocity)
  - Active Layer Thickness
    - 10 inches (standard RM 10.9 cap design average thickness)
    - 1 to 8 inches (thicknesses evaluated for high sub-grade cap)

Table 1. CapSim Model Sensitivity Evaluation

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Darcy Velocity (cm/yr)	Total Active Layer Thickness (inches)	AquaGate Thickness (inches)	Sand Thickness (inches)	AquaGate Volume (% volume)	Time to Breakthrough (years)
307	10	3	7	30	> 250
307	8	2.4	5.6	30	> 250

307	6	1.8	4.2	30	> 250
307	4	1.2	2.8	30	179
307	3	2.4	0.6	80	> 250
307	2.5	2.5	0	100	> 250
307	2	1.6	0.4	80	136
307	2	2	0	100	172
154	2	1.8	0.2	90	> 250
154	2	2	0	100	> 250
154	1	1	0	100	78
77	2	1.2	0.8	60	> 250
77	1	1	0	100	122

Based on the results of the sensitivity analysis, a number of potential active layer designs would be protective in isolating the residual contaminated sediments in the high sub-grade areas. In order to design a protective active layer that can be placed with as little impact as possible to the overall RM 10.9 capping operations, of which the high sub-grade cap is expected to be a small portion, it is recommended that the active layer for the high sub-grade areas be a 6-inch-thick average (4-inch-thick minimum) layer of the same AquaGate/sand mixture that is being placed as the standard RM 10.9 cap. This revised cap cross-section is designed to be protective even if there is no reduction in Darcy velocities. Thus, the revised cap cross-section design is conservative.

The active material/sand mixture thickness should be varied so that top elevation of armor layer is no greater than the original sediment elevation. The active material/sand mixture thickness shall be maximized; however, the active material/sand mixture is not required to exceed the minimum 8-inch thickness specification.

Conclusions and Recommendation

A revised cap cross-section design has been developed for placement in high sub-grade areas where 2 feet of sediment cannot be excavated prior to placing the cap. The revised cap cross-section design for the high sub-grade areas consists of a 6 inches of active material (i.e., the same AquaGate and sand mixture as the standard RM 10.9 cap design), geotextile, 6 inches of Type B (D_{50} = 2 inches) armor stone, and a thin layer of sand just covering the top of the armor stone. The revised cap cross-section is designed to be protective for those conditions in near shore areas (i.e., water depths less than 3-feet-deep) with a high sub-grade.